(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 May 2001 (31.05.2001)

PCT

(10) International Publication Number
WO 01/39364 A1

(51) International Patent Classification[7]: H03D 7/16

(21) International Application Number: PCT/IB00/01843

(22) International Filing Date:
22 November 2000 (22.11.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/447,318 22 November 1999 (22.11.1999) US

(71) Applicant: PARTHUS TECHNOLOGIES PLC. [IE/IE]; 32-34 Harcourt Street, Dublin 2 (IE).

(72) Inventor: MCCULLAGH, Michael, J.; 14 Glenmore Manor, Lambeg, Co. Antim BT27 4BZ (GB).

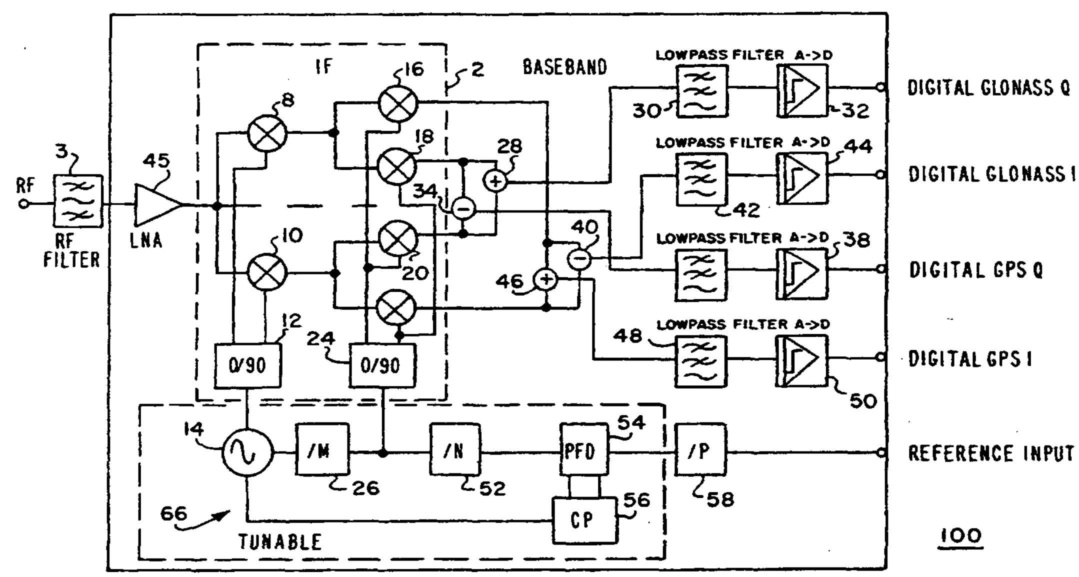
(74) Agent: RAVENEL, Thierry; ICB, Ingénieurs Conseils en Brevets SA, Rue de Sors 7, CH-2074 Marin (CH).

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:
— *With international search report.*
— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: MULTI-BAND RECEIVER



(57) Abstract: A novel technique for the implementation of a single chip navigation/location receiver is disclosed. For example, the receiver derives GPS and GLONAS signals without requiring any external RF image rejection filtering or IF channel select filtering and hence is a fully integrated, single chip device that lends itself to CMOS implementation. The combination of low parts count and CMOS implementation leads to a low cost navigation/location receiver. The receiver is applicable to the growing consumer location market place and operates in urban environments often with limited view of the sky. As disclosed, the multiple band receiver has two chips, RF and Digital Signal Processor (DSP). The use of full RF integration on CMOS however is an excellent starting point for an ultimate RF plus DSP receiver on a single chip.

WO 01/39364 A1

TWO STAGE QUATRATURE DOWNCONVERTER FOR GPS AND GLONASS

BACKGROUND OF THE INVENTION

This invention relates to multi-band receivers and in particular to dual band navigation location satellite receivers.

The need for location based services has increased dramatically in the last two years and is set to grow further in the future. Established systems such as tracking of commercial fleets and valuable articles at risk from theft are obvious examples. A more urgent market driver is the requirement in the United States for mobile phone operators to locate telephones calling the emergency services (911) to within 125m by the year 2001. Significant investigation is now taking place into the use of terrestrial techniques for cell phone locations such as carrying out triangulation on received calls at multiple synchronized based stations. However, it is still believed that the use of satellite navigation techniques provides the best and most accurate solution if the technology required in a handset does not entail significant cost, integrated circuit size, chip area or DC power drain.

Another important issue is the likely availability of RF visible satellites to a receiver operating in an urban environment with limited sky view. This leads to the desirable receiver feature of being able to track not only GPS satellites but GLONASS satellites as well. The Russian GLONASS constellation provides spread spectrum ranging signals similar to GPS albeit by using Frequency Division Multiple Access(FDMA) to distinguish satellites as opposed to the Code Division Multiple Access (CDMA) technique used by GPS. An all embracing receiver that may be referred to as a GNSS1 (Global Navigation Satellite System) receiver, will provide tracking to GPS, GLONASS and Inmarsat GEO satellites that are now providing GPS differential corrections. The Inmarsat signals do not present a problem

to generic GPS front-ends as they are received exactly like GPS signals i.e. 1575.42 MHz and CDMA.

On the basis of market requirement and satellite service availability, the following summations can be made.

- Present and future global position services will depend heavily on satellite navigation techniques.

- The global location engine within a cell phone has to be low cost, low power and small integrated circuit size.

- Requirement for location services in urban areas means a GNSS receiver that supports all available satellite navigation services i.e. GPS, GLONASS, Inmarsat, Gallileo, (differential location).

The disclosed low cost, signal chip GPS/GLONASS (GNSS) RF front-end along with a complementary DSP ASIC meets the above requirements. Present day GPS/GLONASS receivers do exist but they are expensive, power hungry and require a larger integrated circuit surface area. This is because they are usually implemented with a highly integrated GPS RF ASIC and a discrete GLONASS IF section that is used to select the separate GLONASS channel for further processing by the DSP. The GLONASS IF section typically contains a Standing Acoustic Wave(SAW) filter for band selection, downconvert mixer plus Automatic Gain Control(AGC) and a programmable synthesizer. The GPS section of the receiver probably contains at least one SAW device and discrete LC (inductive/capacitance) based filtering. This superheterodyne type topology gives high performance operation in terms of immunity to external interference but will always be expensive, large circuit size and power hungry for incorporation within a wireless terminal such as a mobile phone.

SUMMARY OF THE INVENTION

A fully integrated, RF to baseband solution that does not require any external image or channel reject filtering

and is therefore low cost, has a small area and low power consumption. Most of the problems traditionally associated with direct down conversion such as DC offsets, power supply noise, 1/f noise, poor stability margin and LO self-mixing are eliminated or drastically reduced. Digital quadrature outputs for two navigational bands such as GPS and GLONASS are simultaneously delivered from very simple Analog to Digital Conversion (ADC)structures. Fully integrated first local oscillator and synthesizer require no programmability for simple dual band operation. The receiver topology lends itself to implementation on RF CMOS and is applicable to future signal chip integration with a DSP. The disclosed receiver can receive any two bands of signals simultaneously such as any two GPS, GLONASS, Inmarsat, Gallileo, cellular and DAB.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of a satellite receiver according to the invention;

Figure 2 is a top level simplified schematic of a satellite receiver integrated circuit for the receiver of Figure 1;

Figure 3 is a second top level simplified schematic of a satellite receiver integrated circuit for the receiver of Figure 1;

Figure 4 is a schematic diagram of half of the complimentary DSPs of Figure 1; and

Figure 5 is a schematic diagram of an alternate embodiment of Figure 2.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In Figure 1, to which reference should now be made, there is illustrated a block diagram of a dual frequency or channel receiver 100. The dual channel receiver 100 includes an antenna 1 tuned to receive two different radio frequency signals such as, but not limited to, GPS and GLONASS as shown by waveform 2. The antenna 1 is connected

to the dual channel receiver 100 which converts the received RF signals into two sets of quadrature phase signals at baseband or intermediate frequency signals as shown by waveforms 5 and 7. The dual channel receiver 100 includes an RF section 200 and a BB (Base Band) Section 47 which is made up of the Digital Signal Processing 64 of Figure 2. The two sets of quadrature phase signals are applied to a complimentary DSP 62 of Figure 4 which comprises Digital Signal Processing 64 which is connected to the microprocessor 102 of Figure 2, which communicates with the output device 104 of Figure 2 which may be a device such as a cellular telephone or a video display such as that found in automobiles having a GPS guidance system.

In Figure 2, to which reference should now be made, there is illustrated a simplified schematic diagram of a dual channel receiver 100. A radio frequency signal such as that represented by waveform 49 includes dual bands represented by peaks 11 and 9 and the associated images represented by peaks 13 and 15.

The received signal is down converted by a quadrature down converter that includes the local oscillator (LO1) 14 and an in-phase mixer 8 and a quadrature phase mixer 10. The receiver can be made multi-band by making LO1 14 tunable so that if frequency is located between any two desired bands of frequencies. The down converted signal is represented by waveform 51. Peak 53 is the down converted If signal for the high band. Peak 55 is the second image of peak 53. In multi-band applications, (L02) 57 must also be tunable. Peak 59 represents baseband noise and peak 25 is located at - FIF2 (minus two times the IF frequency) and is the down converted low band signal.

Band separation is provided by a set of quadrature mixers 16, 18, 20 and 22. The outputs of the mixers are combined by adders 46 and 48 and subtractors 40 and 34.

Waveform 27 represents the results of the band

separation for the high band output down conversion. Peak 29 represents the high band located at the IF2 frequency with finite band isolation resulting from limited IQ balance indicated by jagged line 59. Peak 61 is baseband noise. Peak 63 is the second image of peak 29 and peak 65 is the low band frequency after the second down conversion. Lowpass filtering prior to digitalization is represented by dotted line 69 and in multi-band operation, may require adjustment.

The digital data is recovered by the Digital Data Processing 64 and passed to a microprocessor 102 that provides, as is known in the art, audio and/or video information to an output device 104.

Waveform 41 illustrates the high band base band signal after digital filtering via the correlation process. Peaks 71, 73 and 75 represent the unwanted signals that are filtered out.

Figure 3 illustrates a top level simplified schematic of a totally analogue version of the receiver 100 according to the invention. For the purposes of illustration, dual band GPS/GLONASS operating is discussed. Complex (quadrature) demodulator converts RF that has been filtered by a RF filter 3 and amplified by low noise amplifier (LNA) 45 to IF and from IF to baseband or a second IF. In the disclosed embodiment, the conversion is to base band. The complex demodulator includes an in-phase down converter 8 that down converts the received RF signal with an in-phase clock signal from the local oscillator 14. Similarly, a quadrature phase down converter 10 multiplies the received signal by a quadrature clock signal which is the clock signal that has been phase shifted by 90° by the quadrature phase splitter drive 12. The outputs of the in-phase down converter 8 and the quadrature phase down converter 10 are intermediate quadra-phase IF signals.

The in-phase portion of the quadrature IF is applied

to an in-phase IF down converter 16 which multiplies the in-phase IF signal with a mixing signal that is derived by dividing the local oscillator signal by M where M is an integer with the divide by M divider 26. The result of the down conversion is an in-phase IF or baseband signal. However, depending on the application, the resulting signal may be an intermediate IF signal which will require further down converting. A quadrature phase down converter 18 down converts the in-phase IF signal to a quadrature baseband signal by multiplying the in-phase IF signal with a second mixing signal. The second mixing signal is 90° out of phase with the mixing signal and results from the phase splitter 24 shifting the mixing signal by 90°.

A second in-phase down converter 20 converts the quadrature IF signal to a second in-phase signal by multiplying the quadrature IF signal by the mixing signal with the in-phase down converter 20.

A second quadrature phase down converter 22 obtains a second quadrature baseband signal by multiplying the quadrature IF signal with the second mixing signal.

The quadrature phase GLONASS signal is obtained by obtaining the sum of the quadrature baseband signal and the second quadrature baseband signal with the adder 28. The quadrature phase GLONASS signal is filtered by the low pass filter 30 and digitized by the A/D converter 32.

The quadrature phase GPS signal is derived by the subtraction of the quadrature baseband signal from the second in-phase baseband signal with the subtractor 34. The quadrature phase GPS signal is filtered by low pass filter 36 and digitized by the A/D converter 38.

The in-phase GLONASS signal is obtained by the subtraction of the in-phase signal from the second quadrature phase signal with the subtractor 40. The in-phase GLONASS signal is filtered by the low pass filter 42 and digitized by the A/D converter 44.

Adder 46 sums the in-phase baseband signal with the second quadrature baseband signal to obtain the in-phase GSP signal. The in-phase GPS signal is filtered by low pass filter 48 and digitized by the A/D converter 50.

A phase lock loop controls the local oscillator and is turned by detecting the phase difference between a reference input frequency after being divided by the divide by P divider 58 and the mixing signal after being divided by N with the divide by N divider 52. The phase detector 54 detects the phase difference between the reference input and the output of the N divider 52. The Charge Pump plus loop filtering(CP) 56 generates a control signal to adjust the local oscillator 60 from the output of the phase detector PFD 54.

In the prior art, this type of "Weaver" architecture has four outputs that are summed and subtracted appropriately to deliver a baseband I (in-phase) and baseband Q(quadrature phase) signals for the wanted signals while at the same time canceling the unwanted image or signals through destructive interference (i.e. an active image reject mixer). However, in the present invention, a multi-band receiver is disclosed where the construction and cancellation effects are used to simultaneously receive two separate navigation signals. The band separation works on the principle that, for the described embodiment, frequencies above the local oscillator 14 are shifted in phase in the opposite direction to frequencies below the local oscillator 14, which can be tunable for multi-band rather than just dual band operations such as GPS and cellular.

The output of the local oscillator 14 is located in frequency between the GPS L1 band (1565.42 to 1585.42 MHz) and GLONASS bands (1597.78125 to 1609.03125 MHz) so that the GPS L1 band is effectively the image of the GLONASS band. Then after the 2nd complex down conversion with the

down converters 16, 18, 20 and 22, the final four outputs of the structure are summed by adders 28 and 46 and subtracted by subtractors 34 and 40 as appropriate to deliver GPSI, GPSQ, GLONASSI and GLONASSQ channels at either a low IF or baseband as previously discussed. In other words, the complex processing provided by the disclosed embodiment is being used to separate and to access the signals in what are traditionally viewed as the desired and image bands (above and below the local oscillator 14). It is important to note that for the GPS channel, all of the spectrum above the LO is canceled out by the disclosed embodiment, the top of the band being limited by the input RF filter 3.

Similarly, for the GLONASS channel, all of the spectrum below the local oscillator 14 appears as an image and is canceled out with the bottom of the band being limited by the low side roll-off of the RF filter 3. Hence the complete receiver accepts both RF GPS and GLONASS signals at its input and translates these to separate, physical channels at baseband for low pass filtering. Although the GPS spectrum is spread over 20 MHz, for C/A code (i.e. typical commercial receiver) only 4 MHz at most is required for low cost applications. In the case of the GLONASS spectrum, the full band of 11.25MHz is required at present to receive the available satellites. There are plans to reduce the top end of the GLONASS band to 1604.53125 i.e. a reduction in bandwidth to 6.75MHz. The end result is to move frequencies away from the radio astronomy band. The band separation that exists leads to a first IF of close to 14 MHz. If the second complex down conversion is to a low IF then this should be close to 6MHz to ensure that the bottom GLONASS channel is kept comfortably above DC and thereby avoiding DC offset and 1/f noise created with the direct to baseband approach.

The estimate image rejection delivered by the

disclosed embodiment is 30dB which is adequate for commercial applications, especially given that both the GPS and GLONASS signal are buried in thermal noise at the antenna input, typical received signal to noise ratio for GPS is -22dB. Potential interferences are present at frequencies between the GLONASS and GPS signals (1585.42 to 1597.78125MHz) as all of this spectrum is down converted in the above described embodiment.

However, the ITU classifies the navigation signals transmitted by GPS and GLONASS satellites as part of the Radionaviation-Satellite Service (RSS) to which it has allocated the spectrum from 1559 to 1610 MHz. Hence, there are no significant transmitted powers in this band as RSS has the status of a safety service. Of course, there will always be unintentional and unlicenced transmissions but these are unlikely to present operational problems in the majority of everyday commercial applications. High powered transmitters out of band such as digital cellular at 900 and 1800 MHz are rejected by the input RF filter 3. The linearity of the disclosed receiver, in which band separation is carried out by analogue circuitry, is limited by the second set of down converters 16, 18, 20 and 22 for converting the IF to baseband or a lower IF. These devices have to deal with the complete receiver bandwidth at the input after the gain of the LNA 6 and the RF down conversion. The receiver ruggedness is maximized by ensuring that the linearity of the four down converters 16, 18, 20 and 22 is maximized.

The second IF filtering is different for the GPS and GLONASS channels as the required bandwidths are different. However, lowpass filters 30, 42, 36 and 48 need only to have modest selectivity before analogue to digital conversion by the A/D converters 32, 44, 38 and 50; provided the roll-off in the RF filter 3 adequately reduces out of band interferers. This is because in the DSP part

of the Digital Data Processing 64, after final down conversion to baseband, both GPS and GLONASS digital channels are correlated with locally generated codes. This operation represents close to ideal matched filtering of the signal. The A/D converters 32, 44, 38 and 50 can be very simple for the disclosed embodiment given that a noise signal with little variation in power is being digitized and that only phase information is required ultimately from the recovered signals. Typically, circuits used are 1, possibly 1.5 bit converters with over sampling. The low pass filters 30 and 42 required for the GLONASS channel are selectable between two cut-off frequencies to allow for the present and future spectrum allocation discussed above.

The local oscillator 16, for the disclosed receiver, is very simple. There is no requirement to vary either the RF or IF mixing signals, both are synthesized from an external reference via integer M, N and P frequency dividers 26, 52 and 58. Also, as there are no modulation or switching time requirements on the Phase Lock Loop (PLL) 60 bandwidth, it is tailored to suit the phase noise spectrum of the local oscillator 14.

Figure 4 contains a top level schematic of one half of a typical Digital Data Processing 64 that is incorporated within a complementary DSP 62. The first stage involves a digital complex mix before correlation with a locally generated replica pseudo random noise(PN) code.

The complex mix includes an in-phase baseband mixer 68 that mixes the in-phase digital signal (either GLONASS or GPS depending upon the channel) with the SIN from a SIN map circuit 74 of the carrier NCO from oscillator 76 and a baseband quadrature phase mixer 70 that mixes the quadrature digital signal (either GLONASS or GPS depending upon the channel) with the COSIN of the carrier NCO from a COS map circuit 72 that is connected to oscillator 76.

The oscillator 76 is controlled by the reference input

from the reference frequency circuit, as is known in the art, and an output from the receiver processor 80 that adjusts the carrier NCO phase to be in line with the carrier phase of the recovered in-phase and quadrature phase digital signals. The complex mix is necessary in the GPS case to remove doppler shift and in the GLONASS case for doppler removal plus final channel selection. This process is known as "carrier stripping".

Note that because a perfect local oscillator output exists in the digital domain in terms of quadrature balance, there is not an image problem associated with the final down conversion performed by the complex mix. All negative and positive frequency components of the incoming digitized spectrum, when complex mixed with the oscillator 76, are shifted to the left of frequency axis as shown in Figure 2. This is unlike the case with analogue mixing where positive frequency components are shifted to the left and negative frequency components are shifted to the right. There is the added benefit that the 1/f noise that exists on either side of DC line is shifted to a negative frequency while the desired IF is converted cleanly to baseband.

After the complex mix, the correlation function performed by the complex correlator 82 is after the final conversion to baseband and acts as a matched filter for the received code signal. The correlator 82 is a device such as that disclosed in Chapter 5 of a book entitled <u>Understanding GPS Principles and Applications</u> edited by Elliott D. Kaplan and published by Artech House Publishers, Inc. in 1996. The address for Artech House Publishers is 685 Canton Street, Norwood, Massachusetts 02061.

A phase locked loop that includes a code generator 86, shift register 84 and code NCO oscillator 88 provides early, prompt and late correlation information for tracking the code and delivers the required pseudo range information

for PN codes.

The output 81 of the receive processor 80 which is programed to be a discriminator is in the form of code phase increments to the code NCO oscillator 88.

In a similar manner, the carrier tracking loop has a Costas type discriminator implemented in the receiver processor 80 that updates the carrier phase of the carrier oscillator 76. This delay loop delivers the ephemerides information required for the receiver to compute satellite positions.

The receiver 100, illustrated in Figures 2 and 3, uses a second stage of complex down conversion to implement the required band separation between GPS and GLONASS channels. This has the advantage of being conceptually clear to understand (analogue processing from RF to baseband)as well as offering a real technical benefit in terms of adopting a second IF to minimize the final lowpass filtering requirements before handling the signals over to the complex DSP 62. The penalty paid however is the requirement that the down converters 16, 18, 20 and 24 deliver accurate quadrature balance in terms of both phase and amplitude. However, this can be a challenge when the goal is to make a low cost receiver.

In Figure 5, an alternative embodiment is illustrated that uses exactly the same principles described with the implementation of the receiver 100 of Figure 2 but uses digital rather than analogue band separation.

Figure 5 is a schematic diagram of the resultant RF and first section of the complex DSP 62. As in the embodiment of Figure 3, the received dual band is down converted to quadrature IF by in-phase down converter 8 and the quadrature phase down converter 10. The quadrature IF signal is filtered by the low pass filters 31 (in-phase IF signal) and 37 (quadrature phase IF signals) and digitized by the in-phase A/D converter 33 and quadrature phase A/D

converter 39. With this arrangement, digitization of the complex IF signal takes place after the first down conversion. The digitized IF is presented to a digital version of the quad mixer band separation circuit driven by an NCO. The digital quad mixer includes, for in-phase channel, an in-phase down converter 17 and a quadrature phase down converter 19. The quadrature channel has an in-phase down converter 21 and a quadrature phase down converter 23. Digital mixing signals are provided by a SIN map 74 and a COSIN map 72 and a band separator NCO 77. The band separator NCO 77 is controlled by the reference input and an NCO update developed by the complexed DSP 62. The high frequency channel in-phase signal (in the embodiment of Figure 5 GLONASSI) is the subtraction by subtractor 4 of the output of down converter 17 from the output of down converter 23. The high frequency channel quadrature phase signal (GLONASS Q) is the summation by adder 79 of the output of the down converter 19 and the output of down converter 21. The low frequency channel output includes an in-phase digital signal and a quadrature phase digital signal which is in the described embodiments GPSQ and GPSI. GPSQ is the results of the subtraction by subtractor 35 of the output of the quadrature phase down converter 19 from the output of the in-phase down converter mixer 21. GPSI results from the summation by adder 96 of the outputs of the in-phase down converter mixer 17 and the down converter 23. The correlations of the four signals is performed as in the discussions of Figure 4. The advantages for this particular RF/digital split include: the receiver contains only one RF Quadrature down convert, hence, only one set of quadrature imbalance to degrade performance; digital complex mixing is ideal, there are no problems with finite image rejection, DC offsets LO breakthroughs etc.; the power consumption requirements for digital as opposed to accurate analogue Quadrature mixing is lower; the RF

section has been significantly simplified hence reducing the demand on limited design effort.

Digitizing the RF signal leads to a high, dynamic range for the A/D converters as the image signal has not been suppressed. However, for the disclosed embodiment, this is not a great problem as the spread spectrum navigation signals are buried in thermal noise.

This main disadvantage with digital band separation is that the digitized IF frequency is fixed by the GPS and GLONASS band separation and is higher than in the analogue case. This results in low pass filter corner frequency requirements contained in Table 1.

Channel	Ana.Separation (MHz)	Dig.Separation (MHz)
GPS	8	18
GLONASS	12	18

Table 1: Comparison of low pass filter bandwidth requirements

Minimizing the bandwidth of the low pass filter results in extra rejection at a given frequency offset (i.e. a full octave of separation exists at 16MHz for the analogue band separation, GPS channel). The A/D converter sampling frequency, of course, also has to be higher for digital band separation to satisfy Nyquist.

The receiver 100 has the major advantage of lending itself to full system-on-a-chip type integration. Given the early development status of RF CMOS technology, the first version requires a two chip CMOS solution to ensure that front-end performance is not compromised by a premature level of RF/digital integration. Another possibility is to separate out the LNA 45 from the receiver 100 in order to meet the sub 3dB noise figure required for a satellite navigation receiver.

Although RF CMOS presently lags behind other RF integrated circuit technologies such as bipolar and GaAs in terms of most RF parameters, it does have a significant advantage in terms of maximum achievable mixer linearity. The linear performance of the receiver structure outlined (analogue band separation) is limited by the IF down converters 16, 18, 20 and 22 of Figure 3 hence the need for these devices to have both high compression and IP3 points. RF CMOS mixers are now achieving IIP3 figures of 9dBm while bipolar based circuits with similar noise figure performance are down at -12dBm, i.e. over a 20dB advantage for CMOS.

The second down conversion using down converters 16, 18, 20 and 22 for the analogue band separation case is from first IF (~14MHz) to low second IF (~6MHz). An alternative technique with analogue band separation is to arrange for the second down conversions directly to baseband. With this arrangement, the main problem of direct down conversion receivers has been eliminated (i.e. local oscillator 14 frequency leaking to RF port and being self-down converted to create a DC offset that varies with antenna position, temperature etc.). However, there will still be a certain amount of leakage occurring at the IF. Also, the quadrature down converter 8 and 10 will have inherent offsets even allowing for careful symmetrical layout and good device matching. This means that a certain amount of offset cancellation will be required within this version of the receiver 100. One possible technique for implementing an offset is by providing a summing point in each channel prior to baseband filtering to which an offset current digital to analog converter is connected. These DACs are updated from the DSP using one of a number of well known algorithms.

In the case of the digital band separation implementation of Figure 5, the non-ideal quadrature

problems that limit the performance of the analogue version are removed. The penalty is that a higher IF frequency has to be digitized as previously outlined.

The phase noise requirements of the local oscillator 14 for most applications are not severe with a typical value of -80dBc/Hz at 100kHz offset from carrier being adequate. This allows for full tank circuit (inductor and varactor) integration on the silicon substrate if these components are available from the chosen manufacture or foundry. Aligned with this point is the fact that any phase noise floor associated with the prescaler will not present a problem. Incorporation of the synthesizer with the down conversion, although attractive for maximizing integration level and minimizing cost does increase the technical risk of interference and isolation issues.

The low pass filtering, ADCs and any automatic gain control is used with low cost, front end RF filtering to mitigate the effect of out-of-band blockers that impact directly on the complexity of the baseband filtering required. If necessary, two stages of baseband filter can be used in each channel, a high order switched capacitor filter preceded by a simper antialias filter. Low noise performance is required by the low pass filters 30, 31, 42, 36, 37 and 48 to minimize front end gain requirements and hence maximize receiver linearity.

CLAIMS

The invention having been described, what is claimed is:

1. A dual band receiver comprising:

oscillator means for generating a first mixing signal and a second mixing signal that is a phase quadrature of the first mixing signal;

means for generating a third mixing signal that is lower in frequency than the first mixing signal and a fourth mixing signal that is a phase quadrature of the third mixing signal;

a first frequency channel having a first down converter that receives an input signal and mixes the input signal with the first mixing signal to obtain a first down converted signal, a second down converter that receives the first down converted signal and mixes the first down converted signal with the third mixing signal to obtain a second down converted signal, a third down converter that receives the first down converted signal and mixes the first down converted signal with the fourth mixing signal to obtain a third down converted signal;

a second frequency channel having a fourth down converter that receives the input signal and mixes the input signal with the second mixing signal to obtain a fourth down converted signal, a fifth down converter that receives the fourth down converted signal and mixes the fourth down converted signal with the third mixing signal to obtain a fifth down converted signal, a sixth down converter that receives the fourth down converted signal and mixes the fourth down converted signal with the fourth mixing signal to obtain a sixth down converted signal;

a first adder circuit operatively connected to receive the third and fifth down converted signals and to sum the third and fifth down converted signals to obtain a first quadrature phase output signal;

a first subtractor circuit operatively connected to receive the third and fifth down converted signals and to subtract the third down converted signal from the fifth down converted signal to obtain a second quadrature phase output signal;

a second adder circuit operatively connected to receive the second and sixth down converted signals and to sum the second and sixth down converted signals to obtain a first in-phase output signal; and

a second subtractor circuit operatively connected to receive the second and sixth down converted signals and to subtract the second down converted signal from the sixth down converted signal to obtain a second in-phase output signal.

2. The dual band receiver according to claim 1 further comprising:

a first analog to digital converter operatively connected to receive the first quadrature phase output signal and to convert the quadrature phase output signal to a first digital signal; and

a second analog to digital converter operatively connected to receive the second in-phase output signal and to convert the second in-phase output signal to a second digital signal.

3. The dual band receiver according to claim 2 further comprising:

a processing unit operatively connected to receive the first and second digital signals and to process the first and second digital signals to obtain an output data signal.

4. The dual band receiver according to claim 3 wherein the processing unit further comprises:

a digital oscillator means for generating a first and second digital mixing signals, the first and second digital mixing signals being in-phase quadrature with one another;

a first digital mixer operatively connected to receive the first digital signal and to mix the first digital signal with the first digital mixing signal to downconvert the first digital signal to obtain a third digital signal; and

a second digital mixer operatively connected to receive the second digital signal and to mix the second digital signal with the second mixing signal to downconvert the second digital signal to a fourth digital signal.

5. The dual band receiver according to claim 4 further comprising:

a complex correlator operatively connected to receive the third and fourth digital signals and to correlate them into a first early signal, a first prompt signal, a first late signal, a second early signal, a second prompt signal and a second late signal.

6. The dual band receiver according to claim 5 further comprising:

a first processing unit operatively connected to receive the first and second early, prompt, and late signals and to process the first and second early, prompt, and late signals to obtain first global positioning data.

7. The dual band receiver according to claim 6 further comprising:

an output means operatively connected to the first processing unit for providing the global position of the receiver from the first global positioning data.

8. The dual band receiver according to claim 6 further comprising:

a third analog to digital converter operatively connected to receive the second quadrature phase output signal and to convert the second quadrature phase output signal to a fifth digital signal; and,

a fourth analog to digital converter operatively connected to receive the first in-phase output signal and to convert the first in-phase output signal to a sixth digital signal.

9. The dual band receiver according to claim 8 further comprising:

a second processing unit operatively connected to receive the fifth and sixth digital signals and to process the fifth and sixth digital signals to obtain a second position data.

10. The dual band receiver according to claim 9 further comprising:

an output means operatively connected to the first and second processing units for providing the global position of the receiver from the first and second global positioning data.

11. A dual band receiver comprising:

oscillator means for generating a first mixing signal and a second mixing signal that is a phase quadrature of the first mixing signal;

digital oscillator means for generating a first digital mixing signal that is lower in frequency than the first mixing signal and a second digital mixing signal that is that is a phase quadrature of the first digital mixing signal;

a first frequency channel having a first down converter that receives an input signal and mixes the input signal with the first mixing signal to obtain a first down converted signal, a first analog to digital converter operatively connected to receive the first down converted signal and converted it to a first digital down converted signal, a second down converter that receives the first digital down converted signal and mixes the first digital down converted signal with the second digital mixing signal to obtain a second down converted signal, a third down converter that receives the first digital down converted signal and mixes the first down converted signal with the third mixing signal to obtain a third down converted signal;

a second frequency channel having a fourth down converter that receives the input signal and mixes the input signal with the second mixing signal to obtain a fourth down converted signal, a second analog converter operatively connected to receive the fourth down converted signal and to convert it to a fourth digital down converted signal, a fifth down converter that receives the fourth digital down converted signal and mixes the fourth digital down converted signal with the second mixing signal to obtain a fifth down converted signal, a sixth down converter that receives the fourth digital down converted signal and mixes the fourth digital down converted signal

with the third mixing signal to obtain a sixth down converted signal;

a first adder circuit operatively connected to receive the third and fifth down converted signals and to sum the third and fifth down converted signals to obtain a first quadrature phase of an output signal;

a first subtractor circuit operatively connected to receive the third and fifth down converted signals and to subtract the third down converted signal from the fifth down converted signal to obtain a second quadrature phase output signal;

a second adder circuit operatively connected to receive the second and sixth down converted signals and to sum the second and sixth down converted signals to obtain a first in-phase output signal; and

a second subtractor circuit operatively connected to receive the second and sixth down converted signals and to subtract the second down converted signal from the sixth down converted signal to obtain a second in-phase output signal.

12. The dual band receiver according to claim 11 including a processing unit comprising:

a digital oscillator means for generating a third and fourth digital mixing signals, the third and fourth digital mixing signals being in-phase quadrature with one another;

a third digital mixer operatively connected to receive the first quadrature phase signal and to mix the first quadrature phase signal with the third digital mixing signal to down convert the first quadrature phase signal to obtain a fifth digital signal; and

a fourth digital mixer operatively connected to receive the second in-phase signal and to mix the second in-phase signal with the fourth mixing signal to down convert the second in-phase signal to a sixth digital signal.

13. The dual band receiver according to claim 12 further comprising:

a complex correlator operatively connected to receive the fifth and seventh digital signals and to correlate them into a third early signal, a third prompt signal, a third late signal and a fourth early signal, a fourth prompt signal and a fourth late signal.

14. The dual band receiver according to claim 13 further comprising:

a processing unit operatively connected to receive the third and fourth early, prompt, and late signals and to process the third and fourth early, prompt, and late signals to obtain first global positioning data.

15. The dual band receiver according to claim 14 further comprising

an output means operatively connected to the processing unit for providing the global position of the receiver from the first global positioning data.

16. The dual band receiver according to claim 11 wherein the processing unit further comprises:

a digital oscillator means for generating a third and fourth digital mixing signals, the third and fourth digital mixing signals being in-phase quadrature with one another;

a third digital mixer operatively connected to receive the second quadrature phase signal and to mix the second quadrature phase signal with the third digital mixing signal to down convert the second quadrature phase signal to obtain a fifth digital signal; and

a fourth digital mixer operatively connected to receive the first in-phase signal and to mix the first in-phase signal with the fourth mixing signal to down convert the first in phase signal to a sixth digital signal.

17. The dual band receiver according to claim 16 further comprising:

a complex correlator operatively connected to receive the fifth and seventh digital signals and to correlate them into a third early signal, a third prompt signal, a third late signal and a fourth early signal, a fourth prompt signal and a fourth late signal.

18. The dual band receiver according to claim 17 further comprising:

a processing unit operatively connected to receive the third and fourth early, prompt, and late signals and to process the third and fourth early, prompt, and late signals to obtain second global positioning data.

19. The dual band receiver according to claim 18 further comprising

an output means operatively connected to the processing unit for providing the global position of the receiver from the second global positioning data.

20. A dual band receiver comprising:

oscillator means for generating a first mixing signal and a second mixing signal that is a phase quadrature of the first mixing signal;

means for generating a third mixing signal that is lower in frequency than the first mixing signal and a fourth mixing signal that is that is a phase quadrature of the third mixing signal;

a first frequency channel having a first down converter means for receiving an input signal and for mixing the input signal with the first mixing signal to obtain a first down converted signal, a second down converter means for receiving the first down converted signal and for mixing the first down converted signal with the third mixing signal to obtain a second down converted signal, a third down converter means for receiving the first down converted signal and for mixing the first down converted signal with the fourth mixing signal to obtain a third down converted signal;

a second frequency channel having a fourth down converter means for receiving the input signal and for mixing the input signal with the second mixing signal to obtain a fourth down converted signal, a fifth down converter means for receiving the fourth down converted signal and for mixing the fourth down converted signal with the third mixing signal to obtain a fifth down converted signal, a sixth down converter means for receiving the fourth down converted signal and for mixing the fourth down converted signal with the fourth mixing

22. The dual band receiver according to claim 21 wherein the processing unit further comprises:

a digital oscillator means for generating a first and second digital mixing signals, the first and second digital mixing signals being in-phase quadrature with one another;

a first digital mixer operatively connected to receive the first digital signal for mixing the first digital signal with the first digital mixing signal for down converting the first digital signal to a third digital signal; and

a second digital mixer means operatively connected to receive the second digital signal for mixing the second digital signal with the second mixing signal for down converting the second digital signal to a fourth digital signal; and

a complex correlator means operatively connected to receive the third and fourth digital signals for correlating them into a first early signal, a first prompt signal, a first late signal, a second early signal, a second prompt signal and a second late signal.

23. The dual band receiver according to claim 22 further comprising:

a first processing means operatively connected to receive the first and second early, prompt, and late signals for processing the first and second early, prompt, and late signals to obtain first global positioning data.

24. The dual band receiver according to claim 23 further comprising:

a third analog to digital converter means operatively connected to receive the second quadrature phase output signal and for converting the second quadrature phase output signal to a fifth digital signal;

a fourth analog to digital converter means operatively connected to received the first in-phase output signal for converting the first in-phase output signal to a sixth digital signal; and

a second processing means operatively connected to receive the fifth and sixth digital signals for processing the fifth and sixth digital signals to obtain a second position data.

25. The dual band receiver according to claim 24 further comprising:

an output means operatively connected to the first and second processing units for providing the global position of the receiver from the first and second global positioning data.

26. A dual band receiver comprising:

oscillator means for generating a first mixing signal and a second mixing signal that is a phase quadrature of the first mixing signal;

digital oscillator means for generating a first digital mixing signal that is lower in frequency than the first mixing signal and a second digital mixing signal that is that is a phase quadrature of the first digital mixing signal;

a first frequency channel having a first down converter means for receiving an input signal and for mixing the input signal with the first mixing signal to obtain a first down converted signal, a first analog to

digital converter means operatively connected to receive the first down converted signal for converting it to a first digital down converted signal, a second down converter means for receiving the first digital down converted signal and for mixing the first digital down converted signal with the second digital mixing signal to obtain a second down converted signal, a third down converter means for receiving the first digital down converted signal and for mixing the first down converted signal with the third mixing signal to obtain a third down converted signal; a second frequency channel having a fourth down converter means for receiving the input signal and for mixing the input signal with the second mixing signal to obtain a fourth down converted signal, a second analog converter means operatively connected for receiving the fourth down converted signal and for converting it to a fourth digital down converted signal, a fifth down converter means for receiving the fourth digital down converted signal and for mixing the fourth digital down converted signal with the second mixing signal to obtain a fifth down converted signal, a sixth down converter means for receiving the fourth digital down converted signal and for mixing the fourth digital down converted signal with the third mixing signal to obtain a sixth down converted signal;

a first adder means operatively connected for receiving the third and fifth down converted signals and for summing the third and fifth down converted signals to obtain a first quadrature phase of an output signal;

a first subtractor means operatively connected for receiving the third and fifth down converted signals and for subtracting the third down converted signal from the fifth down converted signal to obtain a second quadrature phase output signal;

a second adder means operatively connected for receiving the second and sixth down converted signals and for summing the second and sixth down converted signals to obtain a first in-phase output signal; and

a second subtractor circuit operatively connected for receiving the second and sixth down converted signals and for subtracting the second down converted signal from the sixth down converted signal to obtain a second in-phase output signal.

27. The dual band receiver according to claim 26 including a processing unit comprising:

a digital oscillator means for generating a third and fourth digital mixing signals, the third and fourth digital mixing signals being in-phase quadrature with one another;

a third digital mixer operatively connected for receiving the first quadrature phase signal and for mixing the first quadrature phase signal with the third digital mixing signal for down converting the first quadrature phase signal to obtain a fifth digital signal;

a fourth digital mixer operatively connected for receiving the second in-phase signal and for mixing the second in-phase signal with the fourth mixing signal for down converting the second in-phase signal to a sixth digital signal; and

a complex correlator means operatively connected for receiving the fifth and seventh digital signals and for correlating them into a third early signal, a third prompt signal, a third late signal and a fourth early signal, a fourth prompt signal and a fourth late signal.

28. The dual band receiver according to claim 27 further comprising:

a first processing means operatively connected for receiving the third and fourth early, prompt, and late signals and for processing the third and fourth early, prompt, and late signals to obtain first global positioning data.

29. The dual band receiver according to claim 27 wherein the processing unit further comprises:

a digital oscillator means for generating a third and fourth digital mixing signals, the third and fourth digital mixing signals being in-phase quadrature with one another;

a third digital mixer means operatively connected for receiving the second quadrature phase signal and for mixing the second quadrature phase signal with the third digital mixing signal for down converting the second quadrature phase signal to obtain a fifth digital signal;

a fourth digital mixer means operatively connected for receiving the first in-phase signal and for mixing the first in-phase signal with the fourth mixing signal to down convert the first in phase signal to a sixth digital signal; and

a complex correlator means operatively connected for receiving the fifth and seventh digital signals and for correlating them into a third early signal, a third prompt signal, a third late signal and a fourth early signal, a fourth prompt signal and a fourth late signal.

30. The dual band receiver according to claim 29 further comprising:

a second processing means operatively connected for receiving the third and fourth early, prompt, and late signals and to process the third and fourth early, prompt, and late signals to obtain second global positioning data.

31. The dual band receiver according to claim 30 further comprising

an output means operatively connected to the first and second processing means for providing the global position of the receiver from the first and second global positioning data.

32. A method for receiving dual frequencies comprising:

generating a first mixing signal and a second mixing signal that is a phase quadrature of the first mixing signal;

generating a third mixing signal that is lower in frequency than the first mixing signal and a fourth mixing signal that is that is a phase quadrature of the third mixing signal;

receiving an input signal and mixing the input signal with the first mixing signal with a first down converter to obtain a first down converted signal, receiving the first down converted signal and mixing the first down converted signal with the third mixing signal with a second down converter means to obtain a second down converted signal, receiving the first down converted signal and for mixing the first down converted signal with the fourth mixing signal with a third down converter means to obtain a third down converted signal; receiving the input signal and mixing the input signal with the second mixing signal with a fourth down converter means to obtain a fourth down converted signal, receiving the fourth down converted signal and mixing the fourth down converted signal with the third mixing signal with a fifth down converter means to obtain a fifth down converted signal, receiving the fourth down converted signal and mixing the fourth down converted signal with the fourth mixing signal with a sixth down converter means to obtain a sixth down converted signal;

summing the third and fifth down converted signals to obtain a first quadrature phase output signal;

subtracting the third down converted signal from the fifth down converted signal to obtain a second quadrature phase output signal;

summing the second and sixth down converted signals to obtain a first in-phase output signal; and

subtracting the second down converted signal from the sixth down converted signal to obtain a second in-phase output signal.

33. The method according to claim 32 further comprising:

converting the quadrature phase output signal to a first digital signal;

converting the second in-phase output signal to a second digital signal; and

processing the first and second digital signals to obtain an output data signal.

34. The method according to claim 33 wherein the step of processing further comprises:

generating a first and second digital mixing signals, the first and second digital mixing signals being in-phase quadrature with one another;

mixing the first digital signal with the first digital mixing signal and down converting the first digital signal to a third digital signal; and

mixing the second digital signal with the second mixing signal and down converting the second digital signal to a fourth digital signal; and

correlating the third and fourth digital signals into a first early signal, a first prompt signal, a first late signal, a second early signal, a second prompt signal and a second late signal.

35. The method according to claim 34 further comprising:
processing the first and second early, prompt, and late signals to obtain first global positioning data.

36. The method according to claim 32 further comprising:
converting the second quadrature phase output signal to a fifth digital signal;
converting the first in-phase output signal to a sixth digital signal; and
processing the fifth and sixth digital signals to obtain a second position data.

37. *A method of receiving dual frequencies comprising:*
generating a first mixing signal and a second mixing signal that is a phase quadrature of the first mixing signal;
generating a first digital mixing signal that is lower in frequency than the first mixing signal and a second digital mixing signal that is that is a phase quadrature of the first digital mixing signal;
receiving an input signal and mixing the input signal with the first mixing signal with a first down converter means to obtain a first down converted signal, converting the first down converted signal to a first digital down converted signal, receiving the first digital down converted signal and mixing the first digital down converted signal with the second digital mixing signal with a second down converter means to obtain a second down converted signal, receiving the first digital down converted signal and mixing the first down converted signal with the third mixing signal with a third down converter means to obtain a third down converted signal;
receiving the input signal and mixing the input signal with the second mixing signal with a fourth down converter means to obtain a fourth down converted signal, converting

the fourth down converted signal to a fourth digital down converted signal, mixing the fourth digital down converted signal with the second mixing signal with a fifth down converter means to obtain a fifth down converted signal, mixing the fourth digital down converted signal with the third mixing signal with a sixth down converter means to obtain a sixth down converted signal;

summing the third and fifth down converted signals to obtain a first quadrature phase of an output signal;

subtracting the third down converted signal from the fifth down converted signal to obtain a second quadrature phase output signal;

a summing the second and sixth down converted signals to obtain a first in-phase output signal; and

subtracting the second down converted signal from the sixth down converted signal to obtain a second in-phase output signal.

38. The method according to claim 37 further comprises:

generating a third and fourth digital mixing signals, the third and fourth digital mixing signals being in phase quadrature with one another;

mixing the first quadrature phase signal with the third digital mixing signal to obtain a fifth digital signal;

mixing the second in-phase signal with the fourth mixing signal to obtain a sixth digital signal; and

correlating the fifth and seventh digital signals into a third early signal, a third prompt signal, a third late signal and a fourth early signal, a fourth prompt signal and a fourth late signal.

39. The method according to claim 38 further comprising:

processing the third and fourth early, prompt, and late signals to obtain first global positioning data.

40. The method according to claim 38 further comprising:

generating a third and fourth digital mixing signals, the third and fourth digital mixing signals being in-phase quadrature with one another;

mixing the second quadrature phase signal with the third digital mixing signal to obtain a fifth digital signal;

mixing the first in-phase signal with the fourth mixing signal to obtain a sixth digital signal; and

correlating the fifth and seventh digital signals into a third early signal, a third prompt signal, a third late signal and a fourth early signal, a fourth prompt signal and a fourth late signal.

41. The method according to claim 40 further comprising:

processing the third and fourth early, prompt, and late signals to obtain second global positioning data.

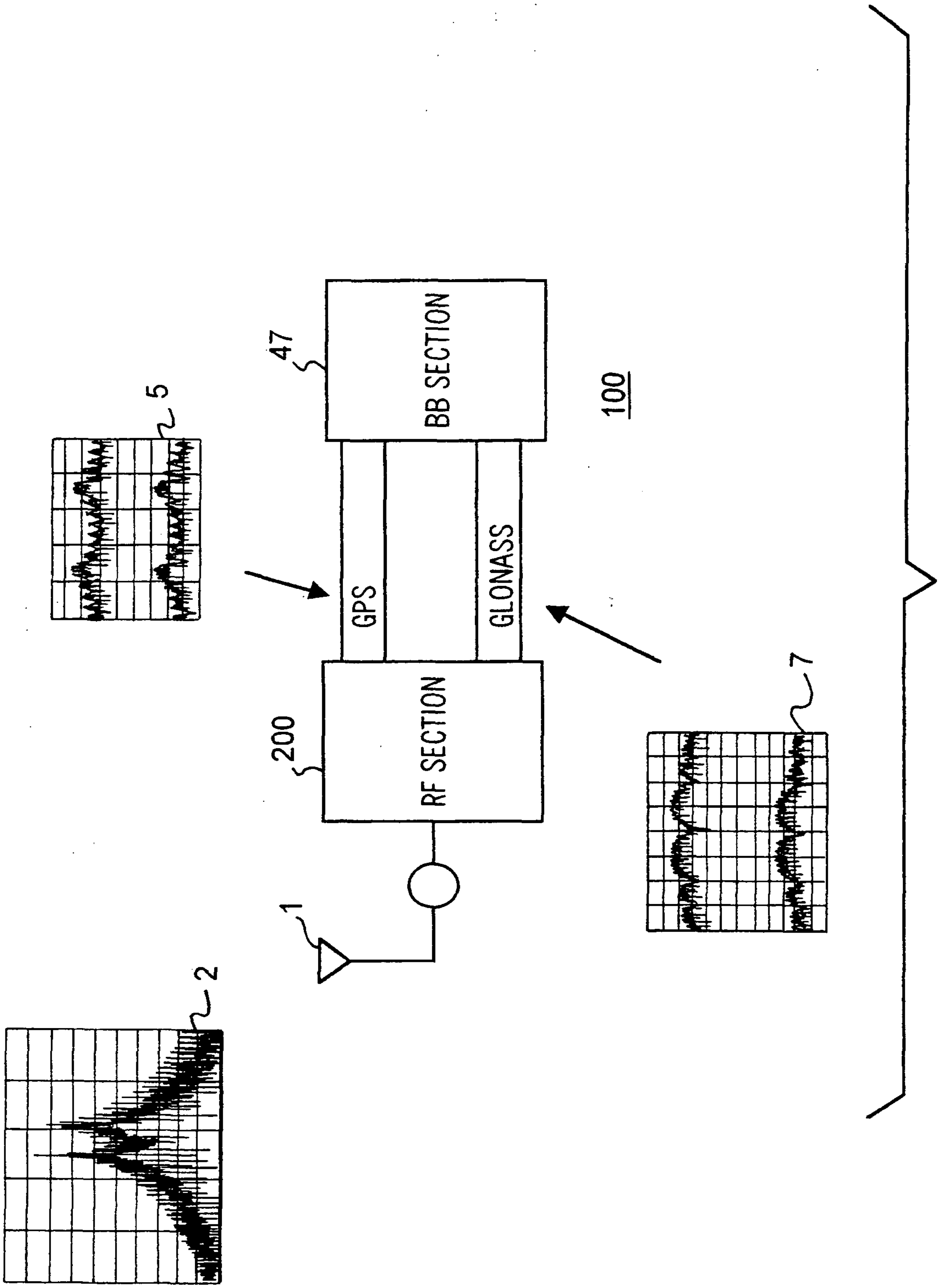
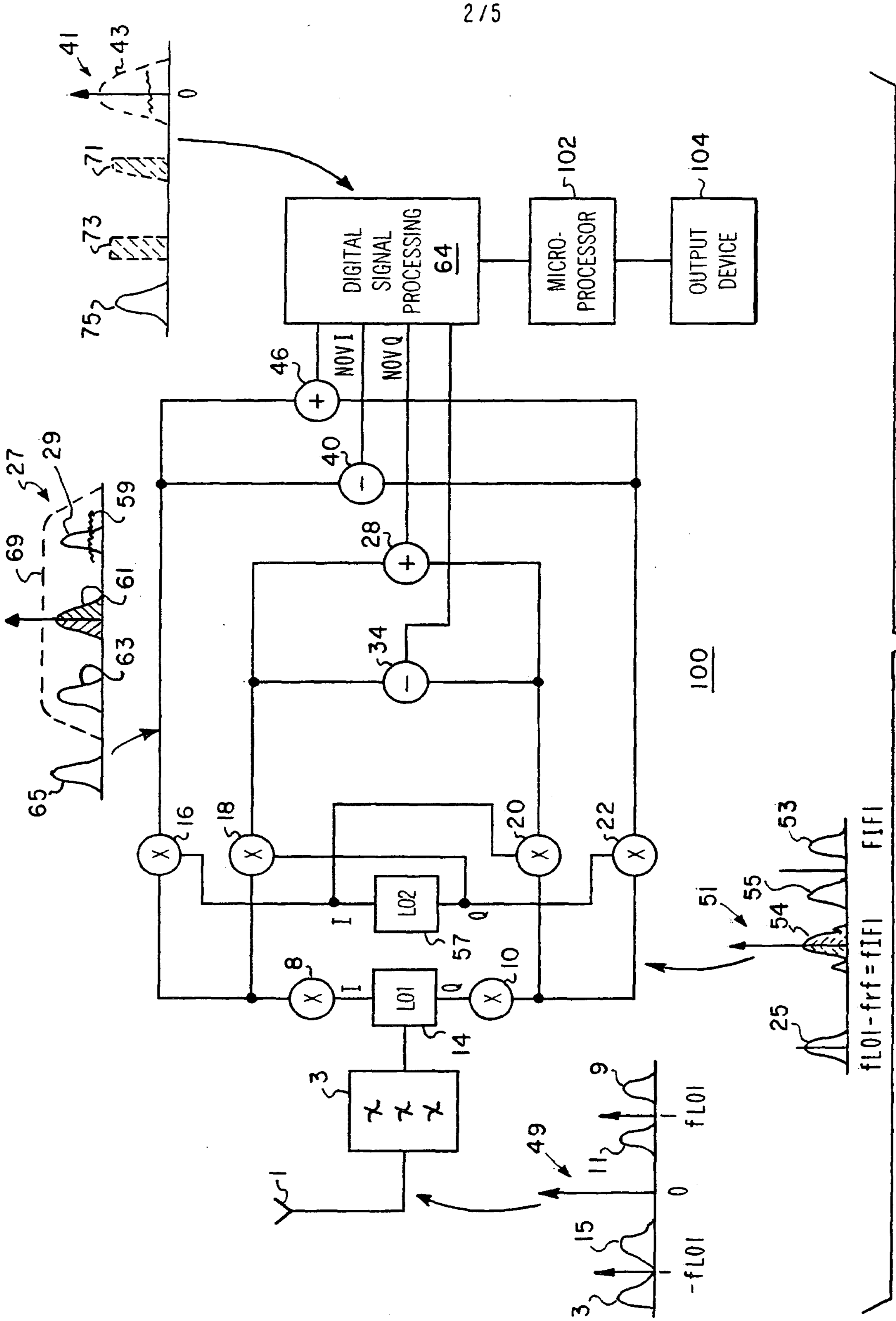


FIG.1



DIGITAL SIGNAL PROCESSING 64
MICRO-PROCESSOR
102
OUTPUT DEVICE
104
NOV I
NOV Q
LO1
LO2
100
fLO1-frf=fIFI
FIFI
-fLO1
fLO1

FIG. 2

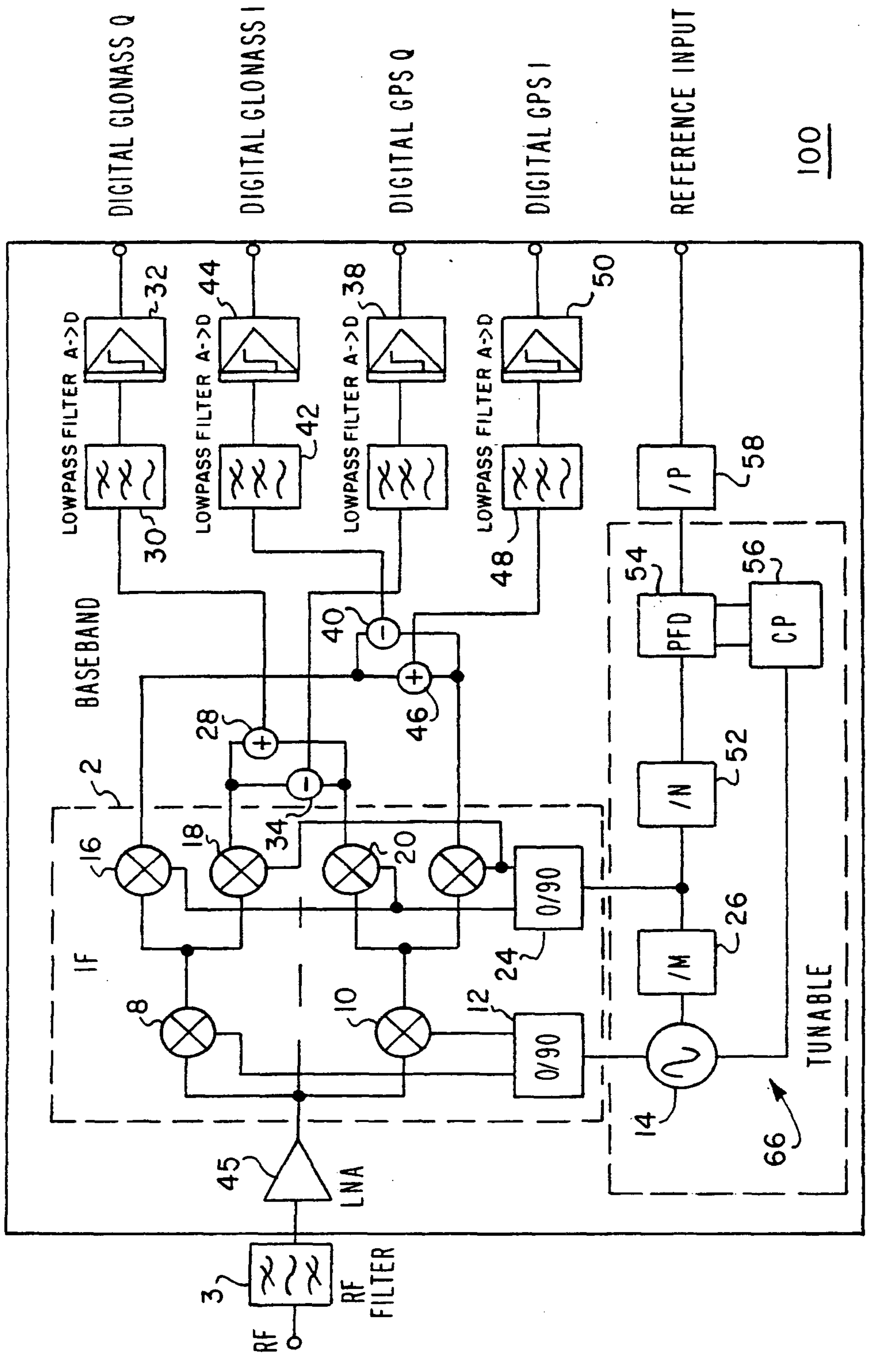

DIGITAL GLONASS Q
DIGITAL GLONASS I
DIGITAL GPS Q
DIGITAL GPS I
REFERENCE INPUT
100
LOWPASS FILTER
A->D
32
44
38
50
30
42
48
58
/P
BASEBAND
54
56
PFD
CP
40
46
28
2
16
18
34
20
/N
52
IF
8
10
12
24
0/90
0/90
/M
26
TUNABLE
14
66
45
LNA
3
RF
RF FILTER

FIG. 3

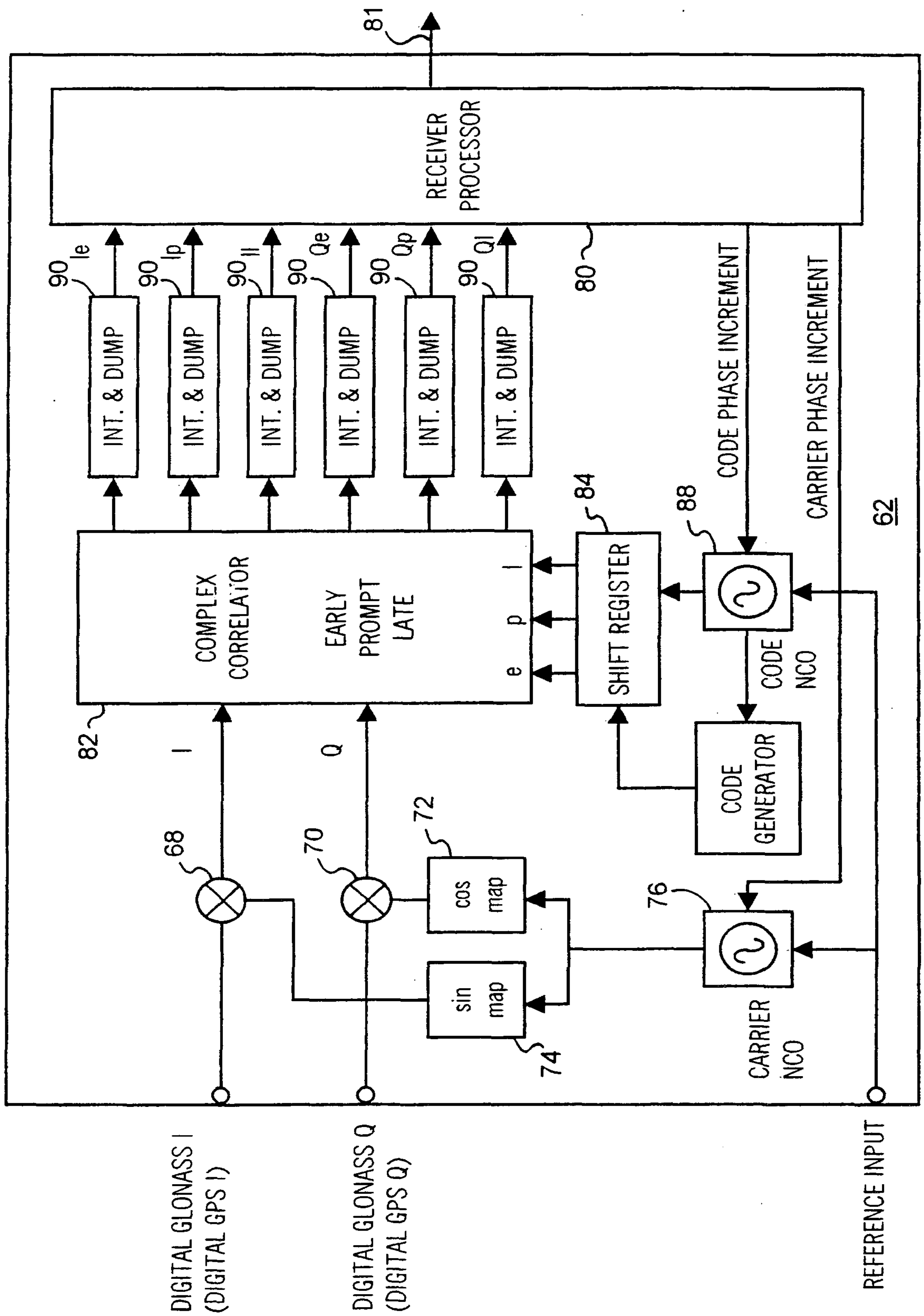

81
RECEIVER PROCESSOR
80
90_{Ie}
90_{Ip}
90_{Il}
90_{Qe}
90_{Qp}
90_{Ql}
INT. & DUMP
INT. & DUMP
INT. & DUMP
INT. & DUMP
INT. & DUMP
INT. & DUMP
CODE PHASE INCREMENT
CARRIER PHASE INCREMENT
COMPLEX CORRELATOR
EARLY PROMPT LATE
e
p
l
82
84
SHIFT REGISTER
88
CODE NCO
CODE GENERATOR
62
I
Q
68
70
72
cos map
sin map
74
76
CARRIER NCO
DIGITAL GLONASS I (DIGITAL GPS I)
DIGITAL GLONASS Q (DIGITAL GPS Q)
REFERENCE INPUT

FIG. 4

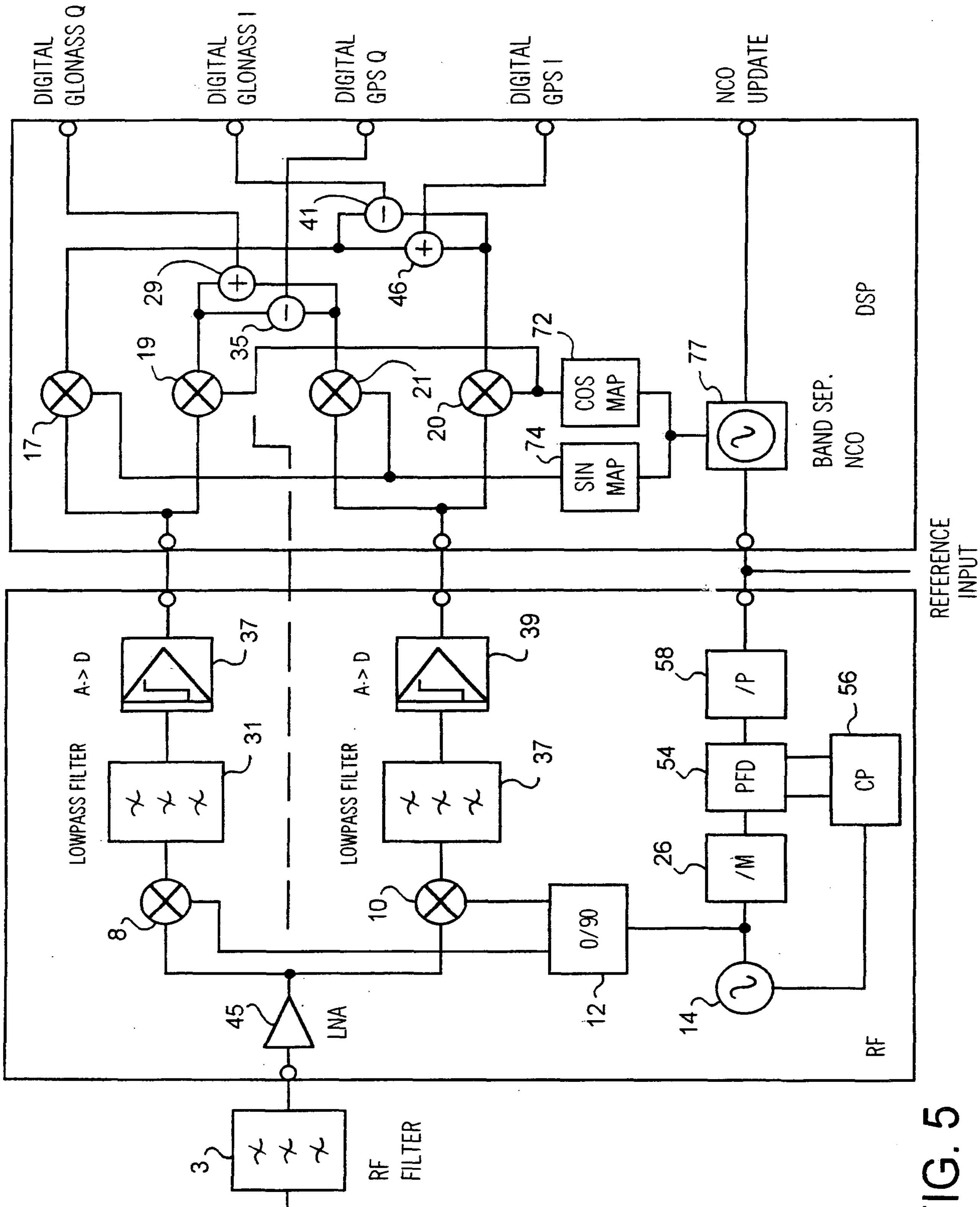

DIGITAL GLONASS Q
DIGITAL GLONASS I
DIGITAL GPS Q
DIGITAL GPS I
NCO UPDATE
17
19
29
35
41
46
21
20
72
74
COS MAP
SIN MAP
77
BAND SEP. NCO
DSP
REFERENCE INPUT
37
39
A-> D
A-> D
LOWPASS FILTER
LOWPASS FILTER
31
37
58
/P
54
PFD
56
CP
26
/M
8
10
0/90
12
14
45
LNA
RF
3
RF FILTER

FIG. 5

INTERNATIONAL SEARCH REPORT

Interr ·nal Application No
PCT/IB 00/01843

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H03D7/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H03D H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99 14863 A (ITALTEL SPA.) 25 March 1999 (1999-03-25) page 6, line 25 -page 7, line 27; figure 2	1-41
A	WO 98 40968 A (PHILIPS ELECTRONICS) 17 September 1998 (1998-09-17) page 5, line 1 - line 25; figure 3	1-41
A	WO 99 57929 A (TRIMBLE NAVIGATION LTD.) 11 November 1999 (1999-11-11) page 9, line 1 -page 10, line 4; figure 1	1-41
A	US 5 548 244 A (R. CLEWER) 20 August 1996 (1996-08-20) column 6, line 42 -column 9, line 53; figures 4-9	1-41

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 May 2001	14/05/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Butler, N

1

INTERNATIONAL SEARCH REPORT

.ormation on patent family members

Intern nal Application No
PCT/IB 00/01843

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9914863 A	25-03-1999	IT MI972086 A EP 1018223 A	15-03-1999 12-07-2000
WO 9840968 A	17-09-1998	EP 0900481 A JP 2000511028 T	10-03-1999 22-08-2000
WO 9957929 A	11-11-1999	US 6122506 A	19-09-2000
US 5548244 A	20-08-1996	NONE	

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

CORRECTED VERSION

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 May 2001 (31.05.2001)

PCT

(10) International Publication Number
WO 01/39364 A1

(51) International Patent Classification[7]: H03D 7/16

(21) International Application Number: PCT/IB00/01843

(22) International Filing Date:
22 November 2000 (22.11.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/447,318 22 November 1999 (22.11.1999) US

(71) Applicant: PARTHUS TECHNOLOGIES PLC. [IE/IE]; 32-34 Harcourt Street, Dublin 2 (IE).

(72) Inventor: MCCULLAGH, Michael, J.; 14 Glenmore Manor, Lambeg, Co. Antim BT27 4BZ (GB).

(74) Agent: RAVENEL, Thierry; ICB, Ingénieurs Conseils en Brevets SA, Rue de Sors 7, CH-2074 Marin (CH).

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

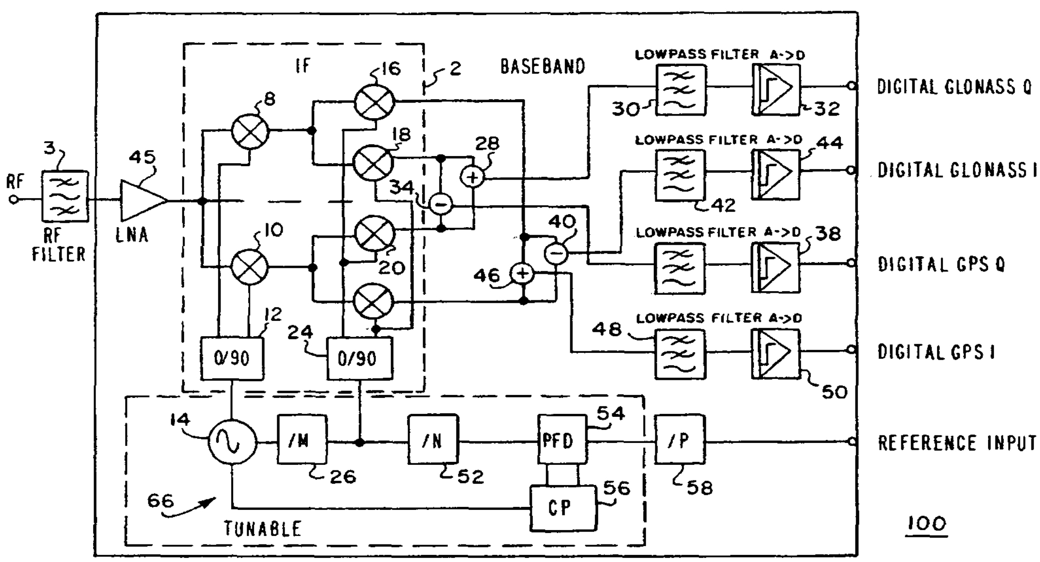
Published:
— *with international search report*

(48) Date of publication of this corrected version:
7 September 2001

(15) Information about Correction:
see PCT Gazette No. 36/2001 of 7 September 2001, Section II

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: TWO STAGE QUATRATURE DOWN CONVERTER FOR GPS AND GLONASS



(57) Abstract: A novel technique for the implementation of a single chip navigation/location receiver is disclosed. For example, the receiver derives GPS and GLONAS signals without requiring any external RF image rejection filtering or IF channel select filtering and hence is a fully integrated, single chip device that lends itself to CMOS implementation. The combination of low parts count and CMOS implementation leads to a low cost navigation/location receiver. The receiver is applicable to the growing consumer location market place and operates in urban environments often with limited view of the sky. As disclosed, the multiple band receiver has two chips, RF and Digital Signal Processor (DSP). The use of full RF integration on CMOS however is an excellent starting point for an ultimate RF plus DSP receiver on a single chip.

WO 01/39364 A1